13

DESCRIPTION OF A PLAN,

&c. &c.

IN July last, I instituted a series of experiments on the Susquehannah river, near the village of Columbia, to ascertain the practicability of passing boats against rapids, by the power of the descending water made to act on paddle wheels. The results were such as to encourage the belief that such a mode of navigation may be advantageously applied in various parts of the United States. The following pages with the annexed plate, will explain the plan, and give an account of the experiments on which such an opinion has been founded. Should any situation favourable to its application exist within your knowledge, and you feel disposed to encourage its adoption, I will promptly attend to any communications you may please to make on the subject. The plan is of my own devising, and has been secured according to the laws of the United States; but rights for using it will be disposed of on very reasonable terms. Should the least doubt exist as to its efficacy, the plan may be tested at a very inconsiderable expense. In fact, I will guarantee to pass boats up planes inclined ten or even fifteen degrees from the horizon, or on any less inclination, provided the channel be sufficiently wide and deep for the passage of the tow-boats and their necessary appendages.

My attention was more particularly directed to the subject of Inland Navigation, by the Report of the Secretary of the Treasury on Public Roads and Canals; printed by order of the Senate of the U. S. April 12th, 1808.

At first it appeared to me, in a country so extensive as ours, so thinly populated, and comparatively so restricted in means, that many years must elapse before a general system of intercourse could be accomplished on any of the plans adopted in the older and more wealthy countries of Europe. In fact, from the mountainous formation of our interior, and the interruption of the navigation of our numerous large rivers, which flow into the Atlantic, by ridges of primitive rock, that the efforts of centuries would be necessary to effect this object on a scale suited to our wants. But reflecting on the various methods that had previously been put in operation to facilitate the navigation of rivers, and the expense essential to their operation, it occurred to me, that one more simple and economical might be devised as an efficient substitute in many situations. And such an one seemed more particularly desirable, in as much as the rapids of some of our principal rivers are bounded by abrupt rocky cliffs, which will not admit of the construction of canals, within the range of expense warranted by any problematical public benefit.

It has been known from time immemorial, that power may be obtained from a current of water made to impinge against the floats of an undershot water-wheel; and that this power will be in proportion to the velocity of the current, and the surface on which it is suffered to act. Hence the idea suggested itself to me, that a power competent to pass boats against the rapids in rivers might conveniently be obtained by means of water-wheels, and other apparatus, supported by buoyant vessels, anchored in appropriate situations. The appendages to a water-wheel, necessary for the passage of boats, would be a windlass and rope that would float on the surface of the water; but, as the course of rivers varies from a direct line, and rapids are frequently of considerable length; objections, arising from the indirect application of the power, and the friction of the water on a great length of line, are evidently presented to a general application of this mode. Nevertheless, there are situations in which it might be adopted to very great advantage; such, for instance, are those where rapids are short and conformed to a right line; and a series of them might be used even where those objections exist in their greatest extent. Such an arrangement would however be attended with considerable cost; and as I had undertaken to devise a plan which, strictly speaking, could be carried into effect at a comparatively small expense, it did not altogether meet my approbation. On some further reflection it occurred to me, that by exposing a greater surface of the floats or paddles of water-wheels to the action of the current, than that opposed to it by the transverse section of boats which supported the wheels, the excess of power so obtained might be applied to propel the boats and other apparatus against the stream. The scheme appeared so plausible, that I determined to make an experiment, but owing to my engagements, no opportunity offered till the summer of 1813, when I put one on a small scale into operation, in presence of a respectable citizen of this place, which answered my most sanguine expectations.

In the summer of 1815, I made some experiments on a water-wheel, which I had caused to be constructed to work a pump by the efflux and reflux of the tides on the Delaware river.

The wheel was sustained by buoyant logs, and could be detached, at pleasure, from the pump fixtures; so that an excellent opportunity was presented for varying the experiments and testing the principle on a more enlarged scale; and the results were more satisfactory than on the former trial.

At this time the public solicitude in regard to internal improvement did not appear to be sufficiently excited to promise any advantage from the publicity of my plan: I therefore suffered it to rest till the summer of 1821; when, the prospects becoming more favourable, I proposed its adoption, on the Delaware and Susquehannah, to several gentleman who, I supposed, felt an interest in improving the navigation of those rivers. I heard nothing further on the subject till June, 1822, when I received a letter from Thos. Ellicott, Esqr. of Baltimore, containing information that the Board of Commissioners appointed on the subject of the navigation of the Susquehannah, had determined to make an experiment on my plan for ascending the rapids in rivers; and enquiring whether it would be convenient for me to superintend it at an early period. In consequence of which I visited that city, and subsequently instituted a series of experiments with a small boat of the Durham structure, on the Susquehannah near the village of Columbia. They were on a scale approximated to practical utility, and the following is an account of the apparatus and results.

The boat was thirty feet in length from *stem* to *stern;* five feet ten inches *breadth of beam;* about two and a half feet in depth; and constructed of very light materials.

A frame-work, as represented by A. A. Figure 2. in the annexed plate, resting on blocks attached to the gunwales, was placed transversely on the boat, and secured with hinges at g. g. and also with parallel uprights on the opposite side, so as to guide it steadily in the movements required to be made for the progress or safety of the vessel.

A shaft supporting the paddle wheels a. a. and windlass b., and furnished with a pivot at each end, was secured to the frame-work by the pivot boxes h. h.; it was also secured by two rests, supported by the frame work above the gunwales of the boat, in such a manner as to form intermediate pivot-boxes. The paddle-wheels a. a. were each seven feet ten inches in diameter, and contained respectively twelve floats or paddles, which were three feet six inches long, and twelve inches broad.

The windlass b. was of two different diameters. The largest was two feet four inches; and the smallest was fourteen inches.

The drum c. was not used in this experiment, but it would prove beneficial to prevent the chain or rope i. i. from folding on itself in its passage round the windlass. d. d. are friction rollers to facilitate the passage of the chain or rope to and from the boat. e. represents a ring to direct the accession of the chain or rope.

Fig. 1. Represents the *Tow-boat* with another boat *in tow*; and f., in the same figure, the lever and other appendages used for elevating the paddle-wheels above water, whenever circumstances require the *tow-boat* to be anchored, or in other words, for governing the progress of the boat.

Fig. 3. Represents the manner in which the chain or rope should be passed round the windlass and drum.

RECAPITULATION OF REFERENCES.

Fig. 2. A birds-eye view of a tow-boat with her appendages.

A. A. Represents the frame-work for supporting the shaft and paddle-wheels.

a. a. The paddle-wheels.

b. The windlass, c. the drum.

d. d. The Friction Rollers.

e. A guide ring for receiving the chain or rope, at the bow of the tow-boat.

f. Fig. 1. Lever for the government of the paddle-wheels.

g. g. Hinges, on which the frame-work partially turns, whenever the paddle-wheels are required to be elevated or depressed.

h. h. Pivot-boxes, and pivots of the paddle-wheel shaft.

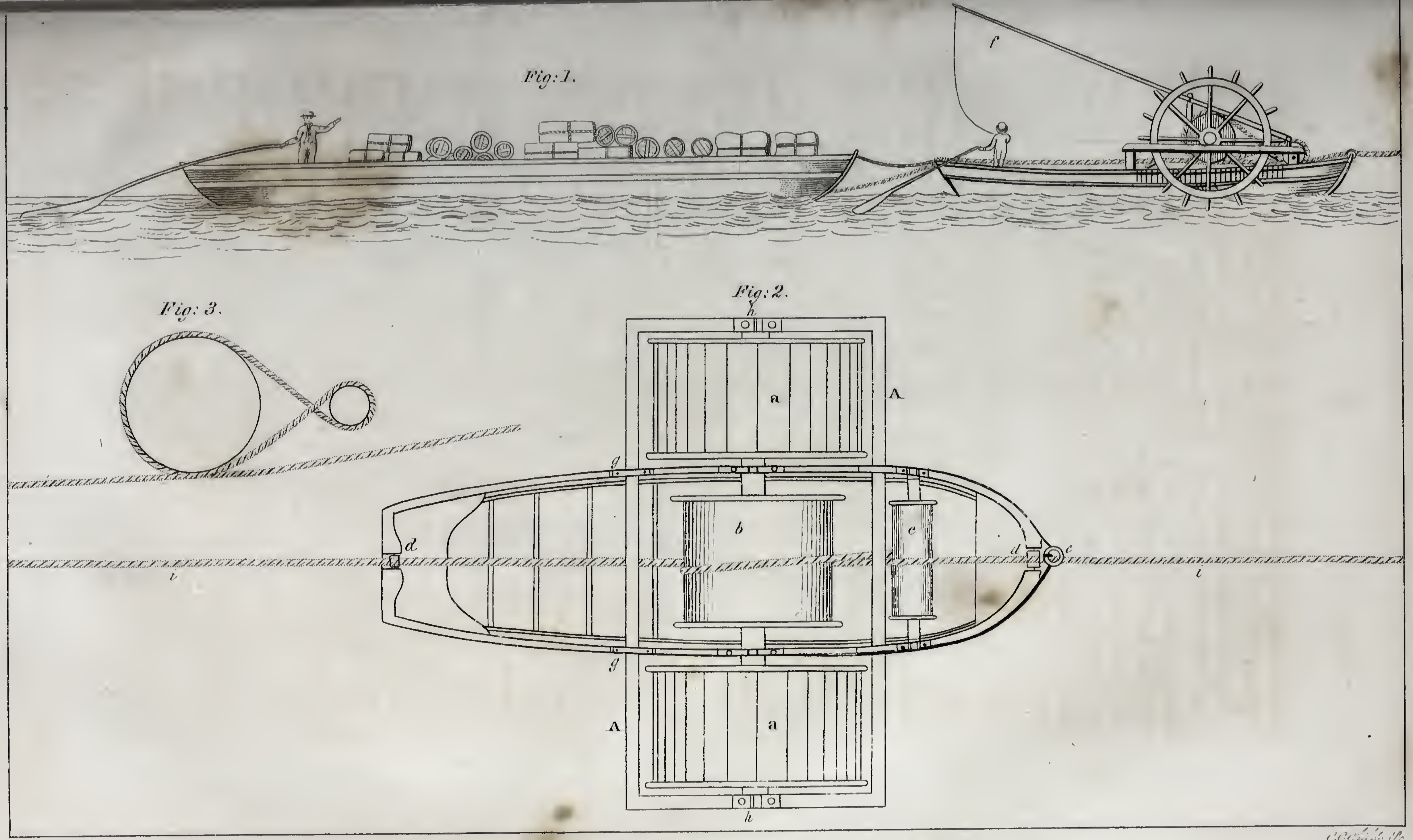
i. i. Rope or chain extended for the whole length of the rapids.

Fig. 3. The manner of passing the rope or chain, perhaps the most advantageously round the windlass and drum.

Fig. 1. Represents a tow-boat passing another boat, freighted with merchandize, against rapids.

The boat, equipped in very nearly the same manner as before described, proved to be top-heavy; and the introduction of about a half ton weight of stones became necessary to ballast it.

In this situation, with four persons in her, the boat was anchored at the end of a line twelve hundred feet long, in the rapids of the Susquehannah opposite to the flour mills of Jacob Strickler, Esqr. just below the village of Columbia. The current ran at the rate of from eight to ten miles per hour; and on lowering the paddle-wheels into it, they were made to revolve so as, by means of the rope passed round the windlass, to propel the boat against the rapids at the computed rate of two and a half or three miles per hour. Within the distance of my experiments the current ran at different rates of velocity; but, in proportion as it increased, was the *headway* of the boat expedited. The rope passed through the ring e. at the bow of the boat, round the windlass b. and then, in-



E. Clark's Plan for Navigating the Rapids of Rivers.

[illegible] Sc.

stead of passing overboard as is represented in the plate, was received and coiled away in the bottom of the boat by persons stationed for the purpose. Having indisputably established the practicability of navagating boats by the application of paddle-wheels, against rapids where, under some circumstances, they could not otherwise be made to pass, it become desirable to ascertain the quantity of power that might, in this way, be conveniently obtained. For this purpose I attached to the stern of the tow-boat, a river boat of the Durham structure which was seventy feet long, and nine or ten feet broad, and, to the stern of the latter, a canoe almost as large as the former. Thus arranged, and while the boats contained the ballast before noticed, several hogsheads of water loose in their bottoms, a quantity of lumber, a heavy ox cart, and fourteen men, the wheels were again lowered into the water, and appeared to propel the whole of this additional incumbrance against the current with the same facility as they operated on the former occasions. It was my wish to have extended these experiments; but I could not, as this boat, which was the only one I could obtain, was engaged in transporting timber, and could not suffer the delay necessary for the object I had in view. It may however be proper to mention that a number of highly respectable gentlemen witnessed the last experiments I made: among them were Jacob Strickler, Michael Elder, Abijah Smith, Jos. Jeffries, and Charles N. Wright, Esqrs. who were of opinion that the boat would have towed ten tons, in addition to what it did on this occasion. In constructing the apparatus, it was calculated for the tow-boat drawing five or six inches more water than it did in any of the experiments I made; consequently the power would have been more than doubled by causing the wheels to dip that much further; and I have no doubt that they would under such an arrangement have been fully competent for the passage of a boat laden with twenty-five or thirty tons weight. And, by a comparison of the resistance with the propelling power, it will readily be perceived that my estimation is not hypothetical; for a boat of the above described dimensions, or say 85 or 90 feet in length, and drawing eighteen inches water, would transport that burden, and scarcely present an area of fourteen square feet resistance to the current;* whereas the perpendicular area of the paddles opposed to the current would be at least equal to that surface; while the difference of leverage between the windlass and paddle-wheels, of the dimensions which I used, was in favour of the latter, and consequently for propelling the boat against the current in the ratio of more than three to one. This excess of power over the resistance is greater than necessary. It should however be considerable, in order to enable an easy passage of the boat in a course varying from the direction of the current. By means of the steering oar, the course of the boat, in the above experiments, was varied at pleasure to 35° and upwards, from the parallel direction of the current; which circumstance, together with the means afforded by the lever and its appendages for arresting its progress altogether, will, it is believed, render this mode of navigation perfectly safe. The chain or rope should be secured by an anchor, or in some other way, at the head of the rapids, and from thence extend down the whole length, into comparatively still water. A buoy should be attached to the lower end, to enable the boatmen to find the chain or rope with facility, whenever the tow-boat may have been detached from it.

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* The sides of boats, it should be remembered, are generally rounded, and their bows of a wedge form, often so considerably inclined to the parallel of the current as to lessen perhaps nearly one half of the resistance.

The use of a chain would be more economical than that of a rope; because, being constantly wet, its oxidation would be exceedingly slow, and its wear would be too inconsiderable to take into calculation;* so that it would necessarily be very durable; while a hemp or grass rope could not be relied on for more than a single season. The chain should be furnished at short distances with swivel links, and near the anchorage with a slip link, so as to detach the tow-boat from it whenever necessary.

The more direct or straight the channel can be constructed, so much the better; but situations will occur in which a conformation to considerable bends will become absolutely necessary. Under such circumstances a series of chains and their appendages, arranged to the respective direct portions of the channel, would perhaps answer a better purpose than a single one conformed to its windings, especially should the deviations from a right line be considerable: but nothing short of experience can satisfactorily direct this arrangement.

Where the channel and current will permit, this kind of navigation may be extended to any distance; and in some places, as in the Missouri, for instance, at a less expense than a common road could be formed; for a chain, every way suitable for the navigation of that stream, with boats of thirty or forty tons burden, would not cost over twenty-five cents per foot; and it is believed that double that sum would purchase one sufficiently strong for the most rapid navigable falls presented in any of our rivers.

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* I observed, about three years since, in the bed of Chester Creek, about two miles above its entrance into the Delaware river, the sills of a grist mill, which it is said, belonged to Governor William Penn, and was the first erected in the then colony of Pennsylvania. They were entirely under water, in a good state of preservation, and contained an iron bolt, which projected a little above the wood, and had suffered only a very slight decomposition on its surface.

Every boat, while ascending, would deposit the chain in nearly the same situation as it was before it passed over the windlass; hence any number of boats, admissible by the length of the chain, could be propelled at the same time in succession against the current; nor would tow-boats be essential for this purpose, since the propelling apparatus is neither so burdensome nor combrous but that it might be conveniently affixed to boats loaded with merchandize. Under all circumstances, however, the chain would continually become shorter, in proportion to the length of its evolutions around the windlasses of all such boats as were made to ascend by it; but this inconvenience could be easily remedied by introducing cleft links at proper distances in the chain, so that pieces could be detached from the anchorage, and whenever necessary, be returned by the descending boats, and be again attached to its lowermost extremity.

Since the completion of the engraving, it has appeared to me that a drum, of the same diameter as the windlass b. placed *abaft* it, and put in motion by a band or cog-wheels connected to the paddle-wheel shaft, would answer a better purpose than the roller or drum c.; because it would always keep the rope or chain tight, while it would equally well prevent its riding or folding on itself. At any rate, a wheel furnished with cogs to fit into the links of the chain, would do away the necessity of duplicate windlasses; though the construction of such a chain would render this mode more expensive.

It will readily be perceived that the power may be augmented almost at pleasure by increasing the surface of the paddles, exposed to the action of the current, beyond the area of the boat's resistance; or by increasing the diameter of the paddle-wheels beyond that of the windlass; or by the application of pulleys; so that I cannot myself perceive any rational objection to the successful and advantageous application of this plan to the navigation of the rapids of rivers, wherever the volume of water is sufficiently large and commodious. It is true that most of the rapids in our large rivers are occasioned by ridges of rocks, which, from the action of running water and other substances on them, frequently present, more or less, the appearance of nodular or detached masses. They are also frequently so extended as almost wholly, in dry seasons, to obscure the current, and often oppose discouraging and, I may say, frightful impediments to improvements suited to this kind of navigation.

But, since a boat may be passed with great facility against any current in which it can safely be anchored; and as the resources of art are at command to form artificial channels, and to coerce the flow of water through them, the difficulties necessary to be overcome are by no means so great as they at first appear.

Rocks situated below the surface of the water may be blowed and removed with nearly as much ease as though they were on dry land; nor will the operation require a much greater expense: and wing and side dams, to the moderate height required, may be constructed with stones and timber, at an expense less, it appears to me, than what equal lengths of turnpike road have generally cost in this State; that is, provided we include and average the whole length of the rapids required to be improved.

It should be recollected that in general only twenty or twenty-four inches depth of water will be wanted in these channels; and that part, if not the whole, of this can be obtained below the natural surface; so that these dams would seldom have to be elevated much above low-water mark.

Besides, in common they could be formed from the rocky fragments cleared from the channel, and would only require, to protect them from injury, a comparatively small number of timber ties and cappings, which, as they would be constantly below the surface of the water, would last, if of durable quality, for a great number of years.* In cold climates, running waters remain exempted or free from ice much longer than when they are in a comparatively stagnant condition; and this difference is particularly observable between large rivers, and canals of the ordinary dimensions; hence a very important advantage would result in favour of the former. But, as applicable to trading intercourse, even this, great as it is, dwindles into insignificance when compared with the immense saving of expense that must result from the adoption of this kind of navigation, wherever circumstances will permit, over that of locks and canals. Without alluding to the circumstance of its being the only practicable mode which, owing to the formation of adjacent country, can in some situations be adopted, it may be accomplished by the disposable means of almost any community; at least where this kind of intercourse is desirable; while the cost of locks and canals is so great, even where sites are favourable, as almost to exclude their use, except in thickly populated and wealthy countries. These, it appears to me, are considerations which claim particular attention in the United States, more especially as our population is much scattered; our means limited; this kind of intercourse very essential in many points of view; and as our country is extraordinarily favoured by

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* See note to page 8.

Nature, in the number, size, extent, and ramification of waters, which are capable of being rendered navigable.

There are obstructions in some of our rivers that will not admit of this kind of navigation; and others again, where its utility has been superseded by the adoption of other methods; but many still remain unimproved, where it may forthwith, or at some future time, be applied with great advantage to the public, and to individuals disposed to embark in the accomplishment of objects so important and praise-worthy. Among these, the St. Lawrence, Sorel, Penobscot, Delaware, Susquehanna, Roanoke, Yadkin, Savannah, and Ohio rivers may be included; and no doubt there are many others in the U. States, with the condition of whose navigation I am ignorant, which are equally well circumstanced for this kind of improvement.

The power of steam has been successfully applied to propel boats against long, and comparatively moderate rapids, and will no doubt be continued so long as their margins are thinly populated, marts of traffic are widely scattered, and fuel is abundant, and even still longer, where expedition is regarded of much importance: but whenever these circumstances shall become reversed, and the intercourse be increased, as in some situations it eventually must, I am decidedly of opinion that some of our long rapid streams may be navigated at a much less expense on this plan, than by the power of steam. And I think I shall be borne out by all those who have had any concern in steam-boat navigation, are acquainted with the enormous expense it involves, and will take the trouble to investigate and compare the merits of the two different modes. At any rate it may be applied with success under circumstances where the power of steam would be altogether useless and unavailing.

CIRCULAR.

Sir,

If facts were wanting to establish the importance and policy of improving the navigation of the Delaware, a list, connected immediately or remotely with the subject, might readily be arranged that would fill a considerable volume,—generally speaking, however, the case is otherwise,—our citizens are in possession of the knowledge; but the very great expense which it has hitherto been thought the measure would involve has had the effect to paralize any attempt commensurate with the promised advantages. Considerable sums of money, it is true, have been expended to clear out the bed of the river, and remove some of the most prominent obstructions to its navigation; but it is the opinion of judicious and respectable men, whose interests have for many years past been connected with this particular intercourse, that, with the exception of two or three instances, more injury than benefit has been done. Nor is this matter of surprise, since they were not directed by experience, nor in conformity with any generally systematized plan. I however intend no reflection on the present commissioners; for, according to their means, their works have been productive of much good. But in order to derive the full benefits of money so expended, it is self-evident that it should be invested in accordance with a project, which contemplates the extension of this navigation, as far into the interior as its combination with natural means and ulterior benefits will justify, and under the direction of managers, who know no division of interests, and are actuated solely for the public good.

The river Delaware, so far as my knowledge extends, is interrupted by a series of rapids, not of great extent or fall, but of a formation which renders the navigation dangerous during the period of floods, and difficult or impassable when the water has subsided.

Besides these, it is impeded by rocks of a nodular form, and by shoals and bars distributed intermediate to the rapids. To show that the navigation is dangerous and difficult, I need only mention that Mr. Cavenagh, at present one of the Legislative council in New Jersey, stated, that within a few years he had known forty rafts wrecked in one season at the Trenton falls, and that he himself had grounded with a Durham boat, containing forty barrels of flour, and drawing only nine inches of water, on Wells falls, within a short time past; while there is annually paid, at the same place, as Mr. Smith, who owns the mills at the tumbling dam falls, informed me, not less than two thousand dollars for pilotage, notwithstanding which, many rafts are wrecked.

The rapids are occasioned mostly by transverse strata of rocks, which in general are narrow, oppose projecting dikes above the bed of the river, and form a species of sub-eddy, in which small rocks and stones are collected and arranged by the current, with a regularity approaching that of a pavement. These last require, comparatively, small expense and labour for their removal; the stratified rocks, particularly those of considerable width, will be more difficult to remove; they will, nevertheless, yield to wedges, augers, and the explosive force of powder, with an expense not greatly exceeding what would be required to cut a similar channel on dry land: they may sometimes be overcome by the means to which we shall be obliged to resort, to obviate the impediments of bars and shoals, that is to say, by partial wiers or wing, or side dams, which, where timber is abundant, will not prove an expensive mode, and from the preservative property of water, will be found exceedingly durable.

In this manner a channel may be cut in the bed of the Delaware, of any requisite breadth and depth, which would, with the assistance of beacons placed at the head of the rapids, render its navigation to tide water easy and safe at all seasons of the year, except when obstructed by ice. To accomplish an ascending navigation, tow boats, furnished with the requisite apparatus for towing against the current, should be established at all the rapids of difficult ascent, so as to enable boats to return with loads, at about the same expense, taking time into the account, as it now costs for the return of unloaded boats.

This plan for ascending rivers is novel, but I have shown, and am ready again to show, that it is not only practicable and safe, but may, in many situations on our large rivers, be economically applied as a substitute for locks and canals, and, in fact, used where they cannot be constructed, and also where steam boats cannot pass.

A canal, with the necessary locks and head gates, cannot be constructed by the falls of Trenton for less than 35 or 40,000 dollars, and yet I will gaurantee to improve the channel of the river, at the same place, so as to pass more boats than a canal could, and fix the necessary boats, &c. for their passage, for from 5 to 7,000 dollars. The same relative proportion in respect to improving the navigation of the Delaware will, I am fully persuaded, hold good as far up as Easton, and perhaps as far as the river is navigable, though I am not sufficiently acquainted with it to pass a decided opinion. The introduction of improvements is generally attended with difficulties, and the present one is particularly so, because, inasmuch as our rivers are public highways, it requires, besides considerable capital, legislative provisions and protection. These circumstances, connected with the advantages which the public will derive from this particularly cheap mode of navigation, have induced me to invite your attention and efforts to the formation of a company, for the accomplishment of this object. The advantages that would result would be most sensibly felt by the farmers; their lands would increase in value; they would find a ready market for commodities at present unsaleable, and save one or two hundred per cent. in the transportation of those that are in demand: the treasures contained in our iron and remote coal and other mines would spring to light; the mercantile and manufacturing communities would, also, from the increase of trade, &c., reap corresponding benefits; and even the boat owners and boat-men, from increasing their annual number of trips, and taking return freight, would come in for their full share of the advantages.

I shall next offer a few remarks on the prospect of profit. The country bordering on or adjacent to this river is rapidly improving, and no doubt at this time contains a population of from 100 to 150,000, which transact nearly all their trading business at New York: besides, the intercourse of a considerable district of country more remotely situated is carried on by the same route. Easton alone, according to the computation of Charles Lombaert, Esq.,* founded on an extensive acquaintance with the subject, and on a minute inquiry, sends annually to Philadelphia 72,000 barrels of produce. And Gen. Bernard and Col. Totten estimate, in their report on the contemplated Morris and Sussex canal, that the amount of trade between the same place and New York would amount to 9,500 tons yearly. Above Easton there are several villages on the Delaware, and wherever it is crossed by bridges or ferries, others would soon make their appearance, should the navigation be once improved; from which circumstances, connected with what has already been observed in regard to natural productions and the cheapness of the mode of improving the navigation, it is a fair calculation that, with a very low toll, it will from the first start pay at least 6 per cent. This, however, is generalizing; but it may serve to invite to a more close inquiry and investigation of the subject. The citizens of New York, who are ever on the alert to extend their trade, think the intercourse with this section of country of sufficient consequence to warrant the construction of one or more canals. The routes for four separate ones to connect the Delaware with the Hudson have actually been surveyed, viz. Wurtzs, the Sussex and Orange, the Sussex and Morris, and the Delaware and Raritan; and laws authorising the construction of the two first and the last, have been passed. Some one or more of these canals is to be constructed ostensibly for the purpose of procuring coal; but that of the trade is regarded as of much the greatest consequence, as will appear by referring to many of the publications on this subject. The commissioners, in their report, contemplate extending the canal to the Susquehannah, and the same measure is favourably spoken of by General Bernard and Colonel Totten, in the paper before referred to.

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* See the Emporium, (Trenton paper,) March 30th, 1822.

But the plan of all others most likely to be undertaken is that of constructing a canal of sufficient elevation on the margin of the river, from near Easton to Trenton, and thence into the Raritan and Delaware. This project originated with General Rutherfurd, and has found influential and warm supporters in New York. Such a canal would operate decidedly against Philadelphia, and the best mode of counteracting its effects would be to improve the channel of the Delaware itself. Finally, in whatever light we view this subject, there can be no doubt as to the importance and policy of accomplishing it, be the expense what it may; for these silent encroachments, though apparently trifling at first, will, in the aggregate amount to much; besides, if the opportunity be lost, it will be found almost as difficult to change the current of trade and public opinion in regard to it, as to lead the waters of the Delaware placidly over its rocky bed.

Very respectfully, yours, &c.

EDWARD CLARK.

Philadelphia.

POSTSCRIPT.

Since the foregoing was put to press, the inquiry, what natural productions are found, in the neighbourhood of the Delaware, for which we are at present to a considerable degree dependent on foreign countries, has been frequently made, and I cannot perhaps answer it better than by inserting some extracts from the report recently made to the legislature of the state of New Jersey, by Charles Kinsey, George P. M'Culloch and Thomas Capner, esquires, who were appointed commissioners, and examined the route of the contemplated canal through Morris and Sussex counties. "The mineralogical report (E) presents a topic of great interest not only to the statesman but to the lover of scientific knowledge. It authenticates a belief, already general though vague, that the north of New Jersey contains a subterraneous wealth, of more solid importance than the treasures of any equal portion of the globe. Inexhaustible supplies of iron, zinc and lime, with copper, black lead, copperas, manganese, and the finest marbles, Spanish brown and yellow ocres; await only the proposed canal to become the copious sources of industry and prosperity."

The same paper, page 12 adds, "by the report of the secretary of the treasury, it would appear that the importation of iron and steel last year, into the United States, was 37,077¾ tons, which reckoned at $75 per ton, is $2,780,731. The fact is however generally admitted, that *well made* Jersey iron is superior to any foreign, and so well is this understood, that a ship fastened with American iron can be insured in New-York, at a cheaper rate than one in which English iron has been used."

"After these momentous facts, it may be unnecessary to add, that, besides iron there are other minerals which would, in themselves, warrant the expense of a canal. We imported last yeart, 10,692 cwt. of Copperas, of which an inexhaustible quantity lies within two miles of our course. The Manganese, necessary in glass houses, potteries of fine ware, and in the bleaching process, abounds; Zinc, not only for making brass, but as a fire-proof covering for houses, and a substitute for copper in the sheathing of ships, exists in masses sufficient to supply the world; copper is discovered in several places, with plumbago, for machinery, crucibles, graphic, and various other uses. Nothing but a canal is wanting to concentrate in New Jersey the enormous expenditure which we lavish for these articles upon foreign nations, and even to become exporters, and supply distant markets."

" By documents presented to the last legislature, the agricultural produce and lumber carried from Sussex to Essex and New York is 6,500 tons, and Hunterdon, Morris and Bergen, may be reckoned at 6,500 tons. N. B. That the counties of Sussex and Hunterdon bound on the Delaware river, and extend from Trenton to the north western boundary of the state.

At page 6, (Document E. accompanying the report) it is remarked, that on the Pompton mountains, carbonate of lime has been found mixed with noble serpentine, forming a beautiful variety of verde antique. A similar rock is met above Philipsburg on the Delaware.*

" In respect to the mineral productions on the Pennsylvania side of the Delaware, my information is very limited; but I have authority to say that iron ore is abundant, and coal is known generally to be, on some of the branches of this river, it also appears by the following extract of a letter from S. Hall to Joseph Chandler, Esq. member of the legislature of New Jersey, dated Deckerstown, November 22d, 1825, and now in my possession, that coal mines have recently been discovered on Broadards creek and elsewhere." " Three quarters of a mile from the gap, says this letter, comes in Cherry creek, a large, dull stream, which rises near the Lehigh mines, and is capable of being made navigable, with a little expense, so that boats can ascend, which can never be the case on the Lehigh, so that that coal company can on this route bring their coal to market much easier than on any other. A half mile above Cherry creek, Broadards creek pours into the Delaware, a stream one third larger than Paulins kill which is now navigable some distance up; six miles above which, and three miles from the stream, a large bed of coal has been lately discovered, which upon trial proves to be as good as ever was worked: in addition to which a bed of coal has been discovered within about ten miles of the Delaware, and very little land carriage, in the neighbourhood of these creeks, (the exact place I do not know) which proves to be good. Mr. Peter B. Shaver and Esq. Putts went up and examined those streams and procured specimens of the coal from the mines which were exhibited at our meeting last Tuesday, so that there is no doubt but what there are inexhaustible quantities of coal in the neighbourhood of our proposed canal,* and in such situations that boats can come and go to the very mines; which will give ours the most decided advantages over every other."

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* Notwithstanding the very extensive limestone formations which afford marble of the most superior quality, within the neighbourhood of Philadelphia, considerable quantities of this article are sent here from lake Champlain through the northern canal; the trade is said to be profitable, and will most likely be continued, until water carriage be substituted for the very expensive one now used to supply us from our own quarries.

Some doubts having been expressed in respect to the useful application of my plan for towing boats against rapids, the following certificates, letters and extracts of letters are published, in order to show that in fact there is no foundation for their existence.

Extracted from a certificate signed as below.

Columbia, *July* 8, 1822.

To whom it may concern,

These are to certify, that we witnessed an experiment made by Edward Clark, at the Mill Rapids, opposite to the mills of Jacob Strickler, Esq. on the Susquehannah river, by which he conveyed or towed over said rapids, against the current, a keel boat constructed to navigate said river, about seventy feet in length, and nine feet in breadth; together with a large sized canoe; fourteen men, and about a half ton of ballast, with a boat of about thirty feet in length, and five 10-12 feet in breadth, supplied with a pair of paddle wheels; and it is our opinion that the apparatus, though constructed in a very temporary manner, would have towed ten tons, in addition to what it did, on the occasion when we were present.

Finally, we think Mr. Clark's plan is well calculated to navigate boats against rapids, in all situations where there is a sufficient depth of water, and the inclination of the bed of rivers is regular, and not amounting to a pitch, or water break.

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* The plan of this canal has recently been projected; it passes through Sussex county, New Jersey, and Orange county in New York, and has been authorised by law in the former state.

Jo. Jefferies,
Charles N. Wright,
Jacob Strickler,
Michael Elder,
Abijah Smith,
Wm. C. Cornwell, }
Peter Rice, } *Pilots.*
Joseph Wade, }

Trenton, *Dec.* 29, 1823.

We, the subscribers, having witnessed the experiments made by Col. Edward Clark with his boat, in the rapids of the Delaware, near Trenton, in towing up a large scow filled with men, through the most impetuous part of the current in said rapids, with the utmost ease, and in the presence of a majority of the members of both houses of the Legislature, as well as of other gentlemen of intelligence and distinction, from the several different sections of the state, who appeared to be sufficiently satisfied with the capacities of the boat for accomplishing the purposes intended; do hereby certify, that we are fully convinced of the advantages that would result to the ascending navigation of the rapids of the Delaware, as also of those of any other river, by the introduction and use of a tow boat, with paddles or wheels, to be propelled by the current, on Col. Clark's plan, to be stationed at the foot of each rapid, to which other ascending boats, laden, might be fastened, and by which, with ease and safety, and with a great saving of time and of personal exertion, they might be passed up, notwithstanding the violence of an opposing current; and do therefore cheerfully submit our opinions in favour of the feasibility of using said boat, as above mentioned, with assured success, and unite in the persuasion, that the interests of watermen would be promoted, and their facilities increased thereby. In testimony whereof, we have subscribed our names, this twenty-ninth day of December, 1823.

D. W. D. Johnston,*
J. R. L. Beatty,
W. L. Prall.†

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* Members of the New Jersey legislature.
† Clerk of the general assembly.

Extract of a letter from Dr. Ewing.

Greenwich, Dec. 27, 1823.

I was much pleased with the experiment made at the Trenton falls, in the presence of the committee, and the members of the legislature generally. The boat, in that instance, ascended with very considerable velocity, against the greatest rapidity of the current of the falls, towing after her a large scow, with thirty or forty persons on board; and, in my opinion, her power was fully competent to have taken up three such scows, loaded in a similar manner. Having directed my attention to your plan of improving the navigation of the Delaware, I do not hesitate to say, that I consider it by far the best that has been proposed.

Dear Sir,
With respect, yours,
W. B. Ewing.*

Col. Edward Clark.

Morristown, (Pa.) Dec. 24, 1823.

We, the undersigned, citizens of Morrisville, certify with pleasure, that we have seen your boat and machinery in operation in the falls at Trenton, (some of us) frequently, and are perfectly satisfied of its capability to propel against the current, two Derham boats at a time; and we believe that, particularly in short falls, it will be a great assistance to the boating navigation.

C. Lombaert,
J. Vanuxem,
Joseph Crozer,
Wm. B. Cooper,
Thos. Clark,
David Eastburn,
George Laning,
Martin Mull,
Richard French,
Moses Winner,
Thomas N. Lawton.

To E. Clark, Esq.

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* Member of the New Jersey legislature.

Extract of a letter from Gen. J. G. Swift, formerly chief Engineer of the United States, dated

New York, *Jan.* 8, 1824.

Dear Sir,

From my examination of your plan, I am convinced that it can be very usefully applied in surmounting the rapids at the Susquehannah and Delaware rivers. The plan is simple and cheap,—I have conversed with colonel Totten, of the United States engineers, who is much pleased with the scheme, and will, no doubt, furnish you with his opinion in its favour.

I remain,
Your very humble servant,
J. G. Swift.

Col. Edward Clark.

The following is from Jos. G. Totten, Esq. Col. U. S. Engineer corps.

Edward Clark, Esq.

Philadelphia, *Jan.* 15*th*, 1824.

Sir,

I have read the pamphlet, you did me the honour to send me, with much attention; and I am happy to say that I can see no reason why your invention of the tow-boat, therein described, should not prove to be one of great public utility.

The principles on which it depends, for power, are certainly incontrovertible. There seems to be no difficulties in applying these principles to the various cases of river rapids, and, above all, most of the applications of the invention may be made at a very small expense.

I have the honour to be,
Very respectfully,
Your most obedient,
Jos. G. Totten.

Much other corroborative testimony might be added, though perhaps without any advantage, for if the foregoing should fail to convince, any further publications would, it appears to me, be altogether useless. E. C.